COMPARATIVE RESISTANCE OF PRUNUS TO CROWN GALL[1]

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IN making a study of the plant disease popularly known as crown gall, plant tumor, or plant cancer, it seemed desirable to ascertain the relative resistance of the different species of *Prunus* to this disease. It was soon evident that the usual methods employed in discovering disease resistance would be of little value. The cause of the disease, life history and pathogenic nature of the organism had already been studied by Dr. Erwin F. Smith[2] and his assistants of the United States Department of Agriculture. They showed, by artificial inoculations, the wide range of plants susceptible to infection and also found that some were apparently resistant. Their experiments encouraged the writer to follow with slight modifications the method of artificial inoculations on a number of species and varieties of the genus *Prunus*. It was hoped that suitable resistant stock might be discovered that would be adapted to the propagation of the stone fruits.

Before considering in detail the methods employed, the general characteristics of the disease will be briefly given. The affected part of the tree, shrub or plant is generally found a little distance beneath the surface of the soil at the crown or point where the roots are given off from the trunk. The disease is characterized by an enlargement or gall more or less spherical in shape and consisting of tissue that is usually much softer in texture than normal. The surface may or may not be covered with a normal bark. This enlargement is now known to be caused by a stimulus that comes from the presence of a definite motile bacterial organism known as *Bacterium* (*Pseudomonas*) *tumefaciens*, which lives within certain of the plant cells in relatively small numbers.

Considerable attention was given to perfecting methods for

[1] Paper No. 28, Citrus Experiment Station, College of Agriculture, University of California, Riverside, California.

[2] United States Department of Agriculture, Bureau of Plant Industry, Bulletins No. 213 and 255, 1911, 1912.

the determination of the relative resistance of the different species of *Prunus*. Most of the different species and varieties were budded or grafted on other stock, the scions or bud wood being secured from several reliable sources, such as the Arnold Arboretum, several of the larger nurseries. The methods used are somewhat different from those usually employed in seeking for disease resistance among plants. The plan was to artificially inoculate with pure virulent laboratory cultures the different kind of *Prunus* under experimentation. A number of suscep-

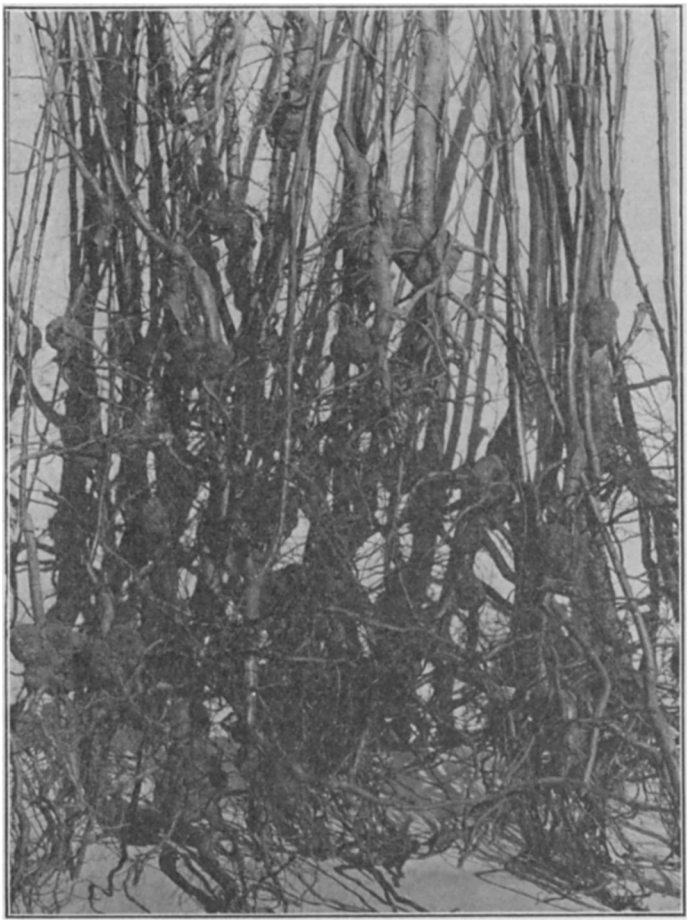

FIG. 1. A bunch of galled peach stock as they often occur in the nursery. Many of the other trees probably had incipient infections unrecognizable at the time of digging, which later developed galls.

tible hosts were always included in the experiment, to act as a check upon the virulence of the culture and any unfavorable climatic condition. In each series of inoculation 5 or 10 punctures were made upon vigorous growing twigs of the current

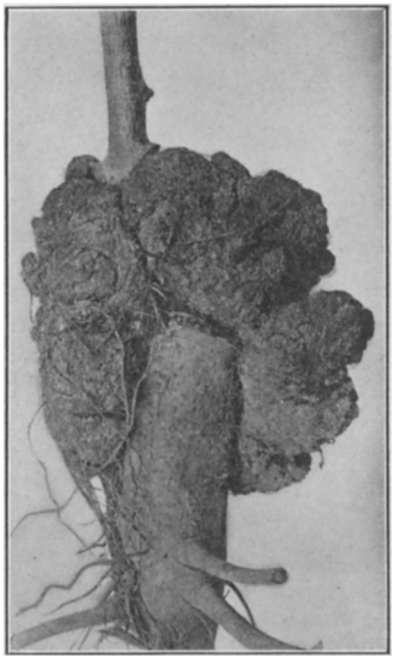

FIG. 2. Natural gall on English walnut in nursery. This gall appeared at the point where the English walnut stock was grafted. It is common practice to bank the dirt about the scions to prevent drying. The California black root is much more resistant.

year's growth. During the experiments of 1914, ten punctures were always made. This number, being the same in all the experiments, was of material aid in the final compilation of results. Other check punctures were made in the same way as in the inoculations except that none of the organisms were placed in the tissue. An ordinary steel needle in a cedar handle was used in making the puncture inoculations. This was first flamed, then used to convey some of the bacterial growth from the test tube to the twig to be inoculated, the puncture being made through the bark and wood of twig. The organism was grown in a medium made as follows: ½ per cent. glucose, ½ per cent. sodium chloride, ½ per cent. meat extract, 1 per cent. peptone, 1 per cent. agar.

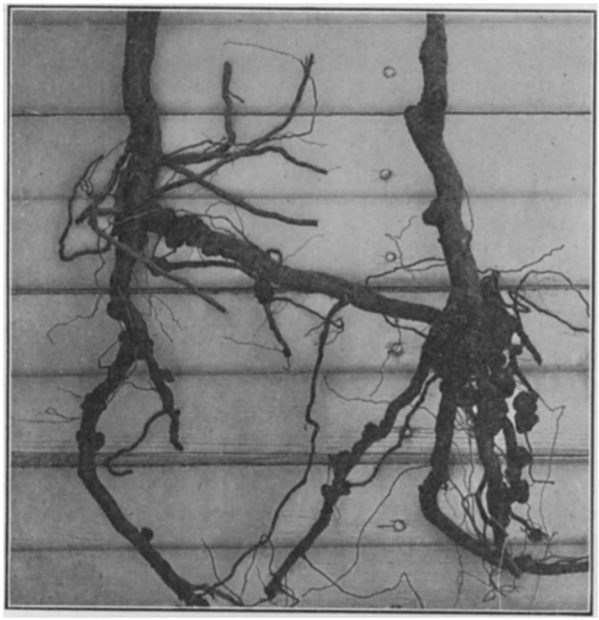

FIG. 3. Two almond roots naturally infected with numerous galls. Such stock would only make inferior trees.

The tubes were incubated from twenty-four to thirty-six hours before being used, at which time there was a vigorous, pearly white, raised growth where the medium was inoculated. The series of inoculations were made a week apart from May 1 to about September 1, 1914. The work of 1913, while similar in nature, was not so extensive as that of 1914. The experiments thus extended over the period of the year when the trees are making their most rapid growth, and should be in their most susceptible condition for infection. The trees were well cared for and made rapid growth during the period the experiments were in progress, and hence were in favorable condition for the development of the disease. No effort was made to protect in any way the punctures, as the use of wax or other covering stimulates callus formation which could easily be confused with the beginning stages of a young gall or with one that has not matured rapidly, as is often the case on inoculated trees showing resistance.

The genus *Prunus* gives a wide range for investigation because of the large number of species and varieties. The following are the species thus far tested by artificial inoculations:

Prunus Allegheniensis, P. Americana, P. Amygdalus, P. andersonii, P. Armeniaca, P. Armeniaca, var. Mikado, *P. Avium, P. Besseyi, P. Caroliniana, P. cerasifera, P. cerasifera,* var. *divaricata, P. cerasifera,* var. *Planteriensis, P. domestica,* several different varieties, *P. eriogyna, P. glandulosa, P. hortulana, P. ilicifolia, P. integrifolia, P. Japonica, P. maritima, P. Mahaleb, P. Mitis, P. monticola, P. Mume, P. munsoniana, P. nigra, P. orthosepala, P. Pennsylvanica, P. Persica,* several varieties, *P. platycarpa, P. pumila* (Linn.), *P. serotina, P. Simonii, P. Watsoni.*

All the above hosts gave positive results from artificial inoculation, except *P. pumila, P. ilicifolia* and *P. Caroliniana.* These three hosts were inoculated during 1913 and 1914 and have always showed negative results. *P. ilicifolia* and *P. Caroliniana* were on their own roots and were not making very rapid growth at the time of the experiment, but it seems almost impossible that they should not have been in a susceptible condition some time during the period from May to September. *P. pumila* made rapid growth, as it was grafted on peach stock, but never showed the least indication of gall formation, nor has it during the ex-

FIG. 4. FIG. 5.

FIG. 4. Artificial gall produced on pepper tree, *Schinus Molle.*

FIG. 5. Artificial gall made by inoculating sour orange seedlings. Citrus stock is only rarely infected naturally with gall, but galls have been artificially produced on lime, lemon, orange and shaddock.

periments of 1915. Only a part of the kinds of *Prunus* just mentioned were thoroughly tested out and these only are included in tabulated results.

It will be noted that Tables II and III represent two varieties of *Prunus domestica.* Not all varieties, however, are equally resistant, but, in general, members of this group are much more

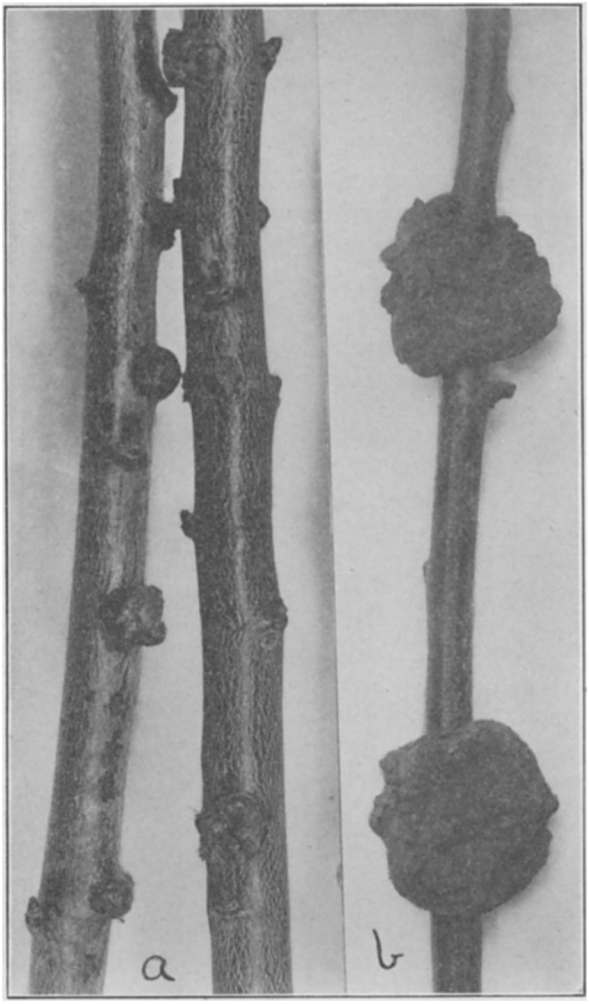

FIG. 6. Artificial galls on *Prunus.* (*a*) German prune, *P. domestica,* a resistant variety. (*b*) Myrobolan, *P. cerasifera,* a susceptible species. Note the difference in size of galls and how in the susceptible kind the galls eventually surround the twig.

TABLE I

A TYPICAL EXPERIMENT WITH *Bacterium tumefaciens*, CULTURE No. 753 C (JULY 13 TO NOVEMBER 15, 1914), TO ILLUSTRATE GENERAL METHODS USED IN SEARCHING FOR A RESISTANT STOCK. A SIMILAR EXPERIMENT TO THIS WAS MADE EACH WEEK FROM MAY TO SEPTEMBER, 1914.

Experiment 20

Experiment Serial No.	No. of Inoculations	Positive Inoculations	Host	Size of Galls in Inches
745	10	2	German prune	$\frac{1}{8}$–$\frac{1}{4}$
746	10	0	German prune (old)	
747	10	5	Damson	$\frac{1}{16}$–$\frac{1}{8}$
748	10	10	*P. triflora*	$\frac{1}{16}$–$\frac{1}{2}$
749	10	10	Wickson	$\frac{3}{8}$–$\frac{3}{4}$
750	10	9	Burbank	$\frac{1}{2}$–$\frac{3}{4}$
751	10	10	Myrobolan	$\frac{1}{2}$–$\frac{3}{4}$
752	10	10	*P. Munsoniana*	$\frac{1}{4}$–$\frac{3}{8}$
753	10	10	*P. davidiana*	$\frac{1}{4}$–$\frac{1}{2}$
754	10	5	*P. maritima*	$\frac{1}{16}$–$\frac{1}{4}$
755	10	4	*P. dasycarpa*	$\frac{1}{16}$–$\frac{1}{8}$
756	10	0	Golden drop (silver prune)	
757	10	8	Reine Claude (green gage)	$\frac{1}{16}$–$\frac{3}{8}$
758	10	10	*P. Simonii*	$\frac{1}{4}$–$\frac{1}{2}$
759	10	10	Royal apricot	$\frac{1}{4}$–$\frac{1}{2}$
760	10	10	Elberta peach	1–1$\frac{1}{4}$
761	10	0	Bitter almond	
762	10	9	*P. hortulana*	$\frac{1}{4}$–$\frac{3}{8}$
763	10	5	*P. Americana*	$\frac{1}{16}$–$\frac{1}{8}$
764	10	10	*Schinus Molle*	1–1$\frac{1}{2}$
765	10	Positive	Oleander	
766	10	0	*P. pumila*	
767	10	0	*P. Watsoni*	
768	10	8	*P. nigra*	$\frac{1}{4}$–$\frac{1}{2}$
769	10	3	*P. serotina*	$\frac{1}{16}$–$\frac{1}{8}$
770	10	10	*P. institia pendula*	$\frac{1}{2}$–$\frac{3}{4}$
771	10	9	*P. mitis*	$\frac{1}{16}$ small
772	10	10	*P. Mume*	$\frac{1}{2}$–$\frac{3}{4}$
773	10	7	*P. Andersonii*	$\frac{1}{4}$
774	10	6	Duane (Tribble)	$\frac{1}{8}$–$\frac{3}{8}$
775	10	2	*P. Planteriensis*	$\frac{1}{16}$–$\frac{1}{8}$
776	10	8	Myrobolan (Arnold)	$\frac{1}{16}$–$\frac{1}{4}$
77	10	9	Myrobolan (sprouts)	$\frac{3}{4}$–1
778	10	10	Myrobolan (young sprouts)	$\frac{1}{2}$–$\frac{3}{4}$
779	10	10	El Paso	$\frac{1}{2}$–$\frac{3}{4}$
780	10	0	Golden beauty	
781	10	10	Arkansas	$\frac{1}{8}$–$\frac{1}{4}$
782	10	1	*P. Virginiana*	$\frac{3}{16}$
783	10	7	*P. cerasifera divarica*	$\frac{1}{2}$–$\frac{3}{4}$
784	10	2	*P. Besseyi*	$\frac{1}{16}$
785	10	0	*P. ilicifolia*	
786	10	0	*P. Caroliniana*	
787	10	9	*P. orthosepala*	$\frac{1}{4}$–$\frac{1}{8}$
788	10	0	Olive	
789	10	2	*P. Armeniaca* Mikado	$\frac{1}{8}$–$\frac{1}{2}$
790	10	5	Italian prune	$\frac{1}{16}$–$\frac{1}{8}$

so than most other species of the genus. By comparison with other tables, it will be found that the galls are of a much smaller size than on most other hosts. The number of positive inocula-

TABLE II

SUMMARY OF ARTIFICIAL INOCULATIONS ON GERMAN PRUNE, *Prunus domestica*. CONCLUDED NOVEMBER 15, 1914

Experiment Serial No.	Date	No. of Inoculations	Positive Inoculations	Size of Galls in Inches
x 500[3]	5/ 3/14	10	0	
532	5/25/14	10	0	
559	6/18/14	10	0	
x 560	6/18/14	10	0	
617	6/29/14	10	6	$\frac{1}{8}$–$\frac{1}{4}$
x 618	6/29/14	20	0	
667	6/29/14	Check	0	
679	7/ 6/14	10	6	$\frac{1}{8}$–$\frac{1}{4}$
x 680	7/ 6/14	10	0	
745	7/13/14	10	2	$\frac{1}{8}$–$\frac{1}{4}$
x 746	7/13/14	10	0	
x 792	7/20/14	10	0	
870	7/27/14	10	0	
x 871	7/27/14	10	0	
934	8/ 3/14	Check	0	
x 935	8/ 3/14	Check	0	
995	8/ 4/14	10	2	$\frac{1}{8}$–$\frac{3}{16}$
x 996	8/ 4/14	10	0	
A 15	8/10/14	10	0	
A 87	8/15/14	10	0	
xA 88	8/15/14	10	0	
*A*125	8/17/14	10	0	
*A*207	8/24/14	10	8	$\frac{3}{16}$–$\frac{1}{16}$
*xA*208	8/24/14	10	0	
*A*242	8/31/14	10	0	
*xA*243	8/31/14	10	0	
		240	24	

tions as given in Tables II and III, is probably somewhat greater than it should be, as in making the estimate of the number of galls on these resistant stocks, any small enlargement was counted, and subsequent examination has shown that many of these small enlargements have not further increased in size. When a gall becomes established in a resistant variety, it makes rapid growth and eventually forms one of good size. These large galls differ from similar galls on peach and many other hosts in that the gall is attached to a relatively small circumference of the infected twig. The gall growth is often nearly at

[3] Numbers that are preceded by an *x* were made on rapid growing twigs of the current year of a seven-year-old tree. The other inoculations in a young tree two years old from the nursery.

TABLE III

SUMMARY OF ARTIFICIAL INOCULATIONS ON ITALIAN PRUNE (FELLENBERG) *Prunus domestica.* CONCLUDED NOVEMBER, 1913

Experiment Serial No.	Date	No. of Inoculations	Positive Inoculations	Size of Galls in Inches
211	5/10/13	5	0	
216	6/ 1/13	5	2	$\frac{4}{16}$–$\frac{1}{16}$
252	6/13/13	5	0	
264	6/16/13	5	0	
270	6/17/13	5	0	
282	7/14/13	15	5	$\frac{2}{16}$–$\frac{2}{16}$–$\frac{3}{16}$–$\frac{4}{16}$–$\frac{8}{16}$
292	7/13/13	5	0	
315	7/19/13	6	2	$\frac{2}{16}$–$\frac{4}{16}$
328	7/21/13	6	1	$\frac{2}{16}$
332	7/21/13	5	0	
343	7/22/13	5	0	
355	7/25/13	10	4	$\frac{1}{16}$–$\frac{3}{16}$–$\frac{2}{16}$–$\frac{1}{16}$
366	7/30/13	10	0	
259	6/ 9/13	5	0	
375	7/30/13	10	0	
390	8/ 9/13	10	0	
406	8/14/13	10	3	$\frac{2}{16}$–$\frac{1}{16}$–$\frac{1}{16}$
420	8/14/13	5	0	
		127	17	

right angles to the twig which makes these galls stand out for considerable distance from the branch.

It is of interest to note that both of these are prunes that have been under cultivation for many years. The German prune is described as being one of the plums longest under cultivation and the oldest of the prune type. Seedlings also come reasonably true to type which might be of importance if grown from seed for a stock. The Italian prune (Fellenberg) is the popular prune of Oregon and has a history of over a century's cultivation. Further experiments among varieties of the *domestica* group are being carried on. The damson which is sometimes included among the domesticas, shows considerable resistance to artificial inoculation.

Prunus cerasifera, var. *Planteriensis,* Table VIII, is described as a double flowering shrub and is the most gall resistant of any of the tested varieties of *cerasifera,* although this resistance should be again determined. Inoculations in the Arnold Arboretum trees, Table IV, did not develop as many galls as those of the larger Myrobolan tree, either because the former were not

[4] A local commercial stock, propagated in California from sprouts, not the true Duane variety, but a small blue plum having the flavor of a Damson, but differing in shape.

TABLE IV

SUMMARY OF ARTIFICIAL INOCULATIONS ON *Prunus cerasifera*. CONCLUDED NOVEMBER, 1914

Prunus cerasifera, Arnold Arboretum Type

Experiment Serial No.	Date	No. of Inoculations	Positive Inoculations	Size of Galls in Inches
595	6/20/14	10	10	$\frac{1}{4}$–$\frac{1}{2}$
646	6/29/14	10	8	$\frac{1}{16}$–$\frac{3}{16}$
709	7 6/14	10	9	$\frac{1}{16}$–$\frac{1}{8}$
776	7/13/14	10	8	$\frac{1}{16}$–$\frac{1}{4}$
22	7/20/14	10	5	$\frac{1}{16}$
902	7/27/14	10	8	$\frac{1}{8}$–$\frac{1}{4}$
963	8/ 3/14	Check	0	
A 1	8/10/14	10	4	$\frac{1}{4}$–$\frac{1}{8}$
*A*111	8/15/14	10	2	$\frac{1}{16}$
*A*149	8/17/14	10	4	$\frac{1}{16}$
*A*225	8/24/14	10	10	$\frac{1}{16}$–
*A*253	8/31/14	10	2	$\frac{1}{16}$
		110	70	

Prunus cerasifera (large four year old seedling).

Experiment Serial No.	Date	No. of Inoculations	Positive Inoculations	Size of Galls in Inches
506	5/ 5/14	10	10	$1\frac{1}{4}$–$1\frac{1}{2}$
538	5/25/14	10	10	$\frac{1}{4}$–$\frac{1}{2}$
566	6/18/14	10	10	$\frac{1}{2}$–$\frac{3}{4}$
62	6/29/14	10	10	$\frac{1}{2}$–$\frac{3}{4}$
649	6/29/14	10	10	$\frac{3}{4}$–1
686	7/ 6/14	10	10	$\frac{1}{4}$–$\frac{1}{2}$
751	7/13/14	10	10	$\frac{1}{2}$–$\frac{3}{4}$
821	7/20/14	10	10	$\frac{1}{2}$–$\frac{3}{4}$
901	7/27/14	10	10	$\frac{1}{8}$–$\frac{3}{4}$
962	8/ 3/14	Check	0	
A 9	8/ 4/14	10	10	$\frac{1}{2}$–$\frac{3}{4}$
A 40	8/10/14	10	10	$\frac{1}{4}$–$\frac{1}{2}$
*A*110	8/15/14	10	10	$\frac{1}{2}$–$\frac{5}{8}$
*A*148	8/17/14	1	10	$\frac{1}{4}$–$\frac{1}{2}$
*A*214	8/24/14	10	10	$\frac{1}{4}$–$\frac{1}{2}$
*A*251	8/31/14	10	10	
		150	150	

growing as rapidly, or, judging from their shrub-like growth, because they are of a different type possibly nearer to the wild type than are those commonly imported from France by nurserymen.

The variety known as Golden Beauty, *P. hortulana,* has thus far shown more marked resistance than other varieties of the species thus far tested. It is interesting to remember that this variety is supposed to have originated in western Texas some-

what out of the natural range of the species. *P. hortulana* and *P. americana* are used as a stock for the native plums in the middle west and east. *P. hortulana* does not sucker, fruits abundantly and has a number of excellent qualities that would recom-

TABLE V

SUMMARY OF ARTIFICIAL INOCULATIONS ON GOLDEN BEAUTY, *Prunus hortulana*. CONCLUDED NOVEMBER, 1914

Experiment Serial No.	Date	No. of Inoculations	Positive Inoculations	Size of Galls in Inches
600	6/20/14	10	7	$\frac{1}{16}$
651	6/29/14	10	3	$\frac{1}{16}$ very small
714	7/ 6/14	10	5	$\frac{1}{16}$–$\frac{1}{8}$
780	7/13/14	10	0	
826	7/20/14	10	4	$\frac{1}{16}$
906	7/27/14	10	1	$\frac{1}{16}$
967	8/ 3/14	Check	0	
A 11	8/ 4/14	10	3	$\frac{1}{8}$
A 44	8/10/14	10		
*A*114	8/15/14	10	1	$\frac{1}{16}$
*A*152	8/17/14	0	1	$\frac{1}{16}$
*A*250	8/29/14	10	0	
		110	25	

mend it as a stock. Further experiments with varieties of this species are being made and its adaptability to various of our stone fruits carefully studied.

TABLE VI

SUMMARY OF ARTIFICIAL INOCULATIONS ON *Prunus pumila* LINN. CONCLUDED NOVEMBER 15, 1914

Experiment Serial No.	Date	No. of Inoculations	Positive Inoculations
580	6/20/14	10	0
635	6/29/14	10	0
766	7/13/14	10	0
849	7/20/14	10	0
88	7/27/14	10	0
9 4	8/ 3/14	Check	0
A 8	8/ 4/14	10	0
A 34	8/10/14	10	0
*A*106	8/15/14	10	0
*A*144	8/17/14	10	0
*A*220	8/24/14	10	0
*A*254	8/31/14	10	0
		110	

Further inoculations of *P. pumila* (thirteen experiments of ten inoculations each or 130) made during the present year, 1915,

in vigorous growing seedlings, gave negative results, agreeing with the results of the two previous years. The experiments thus far conducted show that the species is entirely resistant to artificial inoculations. *P. Besseyi,* closely related to *P. pumila,* also shows considerable resistance.

The two other species of *Prunus* referred to as being resistant are *P. ilicifolia* and *P. Caroliniana.* They are evergreens and are not now considered as strictly belonging to the genus *Prunus.* They do not readily unite by grafting or budding with varieties of the stone fruits. *P. pumila* is a shrub and while this stock readily unites with many of the varieties of the stone fruits it probably would dwarf the tree more or less and might sprout. It is, however, readily grown from pits or cuttings.

TABLE VII

SUMMARY OF ARTIFICIAL INOCULATIONS ON *Prunus.* CONCLUDED OCTOBER 31, 1913

Species	Variety	No. of Inoculations	Positive Inoculations	Per Cent.	Size of Galls in Inches
P. domestica.....	German prune	75	2	$2\frac{2}{3}$	$\frac{1}{16}$–$\frac{1}{8}$
P. domestica.....	German prune	50	5	10	$\frac{1}{10}$–$\frac{1}{8}$
P. domestica.....	Italian prune	127	17	13	$\frac{1}{16}$–$\frac{1}{4}$
P. domestica.....	Green gage	17	4	23	$\frac{1}{16}$–$\frac{3}{8}$
P. insititia.....	Damson	138	51	37	$\frac{1}{4}$–$\frac{3}{4}$
P. domestica.....	Duane	37	15	40	
P. persica	Elberta	61	57	93	$\frac{1}{2}$–$2\frac{1}{2}$
P. triflora × *P. Simonii*.....	Wickson (hybrid)	56	64	98	$\frac{1}{2}$–1
P. triflora.....	Burbank	31	31	100	$\frac{1}{4}$–$\frac{1}{2}$
P. cerasifera.....	Myrobolan	8	8	100	$\frac{1}{2}$–1

In each of the inoculation experiments, ten punctures were made, hence the number of inoculations divided by ten will give the number of separate experiments made with the various hosts.

In the two tables, VII and VIII, where the inoculations of the years 1913 and 1914 have been summarized, there is a reasonable degree of consistency between the percentages shown for the different hosts. Other varieties of *P. persica* possibly should be further tested, although such varieties as Elberta, Saucer or Peento, Salway, Lovell and Muir seedlings have not shown any marked resistance.

Any of the stock as listed in Tables VII and VIII that show less than 50 per cent. infection are more or less promising, for in the experimental work with artificial inoculations from virulent

TABLE VIII

SUMMARY OF INOCULATIONS MADE ON *Prunus*. CONCLUDED NOVEMBER 15, 1914

Species	Variety	No. of Inoculations	Positive Inoculations	Per Cent. of Galls	Size of Galls in Inches
P. pumila.....	2 varieties, Arnold Arboretum	110	0	0	
P. domestica.....	Italian prune	140	10	7	$\frac{1}{16}$–$\frac{1}{8}$
P. cerasifera.....	*P. planteriensis*	40	3	$7\frac{1}{2}$	$\frac{1}{16}$–$\frac{1}{8}$
P. domestica.....	German prune	240	24	10	$\frac{1}{16}$–$\frac{1}{2}$
P. insititia.....	Damson	120	13	10	$\frac{1}{8}$–$\frac{1}{2}$
P. Besseyi.....	————	50	5	10	$\frac{1}{8}$–$\frac{1}{2}$
P. hortulana.....	Golden Beauty	110	25	22	$\frac{1}{16}$–$\frac{1}{8}$
P. amygdalus[4]	Bitter almond	100	22	25	$\frac{1}{8}$–$\frac{3}{8}$
P. domestica.....	Reine Claude (green gage)	90	25	26	$\frac{1}{16}$–$\frac{1}{2}$
P. Armeniaca.....	Mikado	40	11	27	$\frac{1}{16}$–$\frac{3}{16}$
P. angustifolia.....	Watsoni	50	15	30	$\frac{1}{16}$–$\frac{1}{8}$
P. maritima.....	Arnold Arboretum	140	48	34	$\frac{1}{16}$–$\frac{1}{8}$
P. dasycarpa.....	Arnold Arboretum	130	55	42	$\frac{1}{16}$–$\frac{1}{2}$
P. Mitis.....	Arnold Arboretum	60	32	53	$\frac{1}{16}$–$\frac{1}{8}$
P. cerasifera.....	Arnold Arboretum	110	70	63	$\frac{1}{16}$–$\frac{1}{4}$
P. Munsoniana....	Arnold Arboretum	70	48	68	$\frac{1}{8}$–$\frac{3}{16}$
P. Munsoniana....	Arkansas	90	70	77	$\frac{1}{16}$–$\frac{3}{8}$
P. Americana.....	Arnold Arboretum	100	83	83	$\frac{1}{16}$–$\frac{1}{2}$
P. hortulana.....	Arnold Arboretum	130	108	83	$\frac{1}{8}$–$\frac{3}{4}$
P. insititia.....	Pendula	90	77	85	$\frac{1}{16}$–$\frac{3}{4}$
P. davidiana.....	————	110	96	88	$\frac{1}{8}$–$\frac{3}{4}$
Schinus Molle.....	Pepper tree	110	97	88	$\frac{1}{4}$–$1\frac{1}{2}$
P. triflora.....	Burbank	120	109	90	$\frac{1}{2}$–$1\frac{1}{2}$
P. nigra.....	Arnold Arboretum	60	56	90	$\frac{1}{4}$–$\frac{3}{8}$
P. orthosepala.....	Arnold Arboretum	80	72	90	$\frac{1}{16}$–$\frac{1}{8}$
P. Mume.....	Arnold Arboretum	100	91	91	$\frac{1}{4}$–$\frac{1}{2}$
P. Munsoniana....	Pits Arnold	140	130	92	$\frac{1}{16}$–$1\frac{1}{2}$
P. cerasifera.....	*P. divaricata*	100	94	94	$\frac{1}{8}$–$\frac{3}{4}$
P. Persica.....	Elberta	130	122	94	$\frac{1}{4}$–$\frac{3}{4}$
P. Armenica.....	Royal apricot	120	117	97	$\frac{1}{4}$–1
P. triflora.....	Arnold Arboretum	140	137	97	$\frac{1}{8}$–$\frac{3}{4}$
P. Munsoniana....	El Paso	100	97	97	$\frac{1}{4}$–$\frac{1}{2}$
P. cerasifera.....	Sprouts	120	117	97	$\frac{1}{4}$–$1\frac{1}{2}$
P. triflora × *P. Simonii*.....	Wickson (hybrid)	140	138	98	$\frac{1}{8}$–$\frac{3}{4}$
P. cerasifera.....	Tree	150	150	100	$\frac{1}{4}$–$1\frac{1}{2}$
P. monticola.....	Arizona Experiment Sta.	40	40	100	$\frac{1}{2}$–$1\frac{1}{2}$
P. Simonii.....	Arnold Arboretum	130	130	100	$\frac{1}{4}$–$1\frac{1}{2}$

cultures, the different stocks were subject to a more severe test than obtains under the usual field conditions. The more promising of these, the first seven in Table VIII, with the exception of the damson, have already been considered after the various table in which the results were summarized. The damson has often

[5] *Prunus Amygdalus* was not growing well during the last part of the season and no infections showed after that of July 6. Before this time a large percentage of the inoculations were positive. This will be repeated another year.

been used as a stock, but is not popular on the Pacific coast because of its slow growth in the nursery and the difficulty of working it with many of the stone fruits. Duane, *P. domestica,* Table VII, is being used to some extent as a stock in California and shows resistance to gall in old vineyard land where it has been grown for six years. It makes as large a tree as the popular Myrobolan stock. The seedlings are grown from suckers, which give a root likely to sucker. Reine Claude (green gage) variety has shown resistance and would without doubt be a good stock for the domestic type of plums. *P. Armeniaca,* variety Mikado, is an apricot that differs somewhat from the one commonly grown in California. It should be tested out experimentally as a stock for apricots to replace the susceptible one now being used.

The almond, from field observations, is one of our most susceptible stock and this is fully confirmed by the following inoculation experiments: Fourteen different varieties of almond seedlings not summarized in the following tables were inoculated in April of 1913 at the University Farm at Davis, California. These in all cases showed a high percentage of infection. So far the peaches and almonds have shown only slight resistance.

It will be noted that our most popular stocks as Myrobolan, peach, apricot and almond are very susceptible, which only goes to confirm field observations that the stock used for the stone fruits are very susceptible to crown gall.

The work so far conducted shows that seedlings of the German and Italian prunes might be promising stock for certain of the stone fruits, probably those of the *domestica* type. However, no definite recommendations can be given, as the work is now only in its preliminary stages.